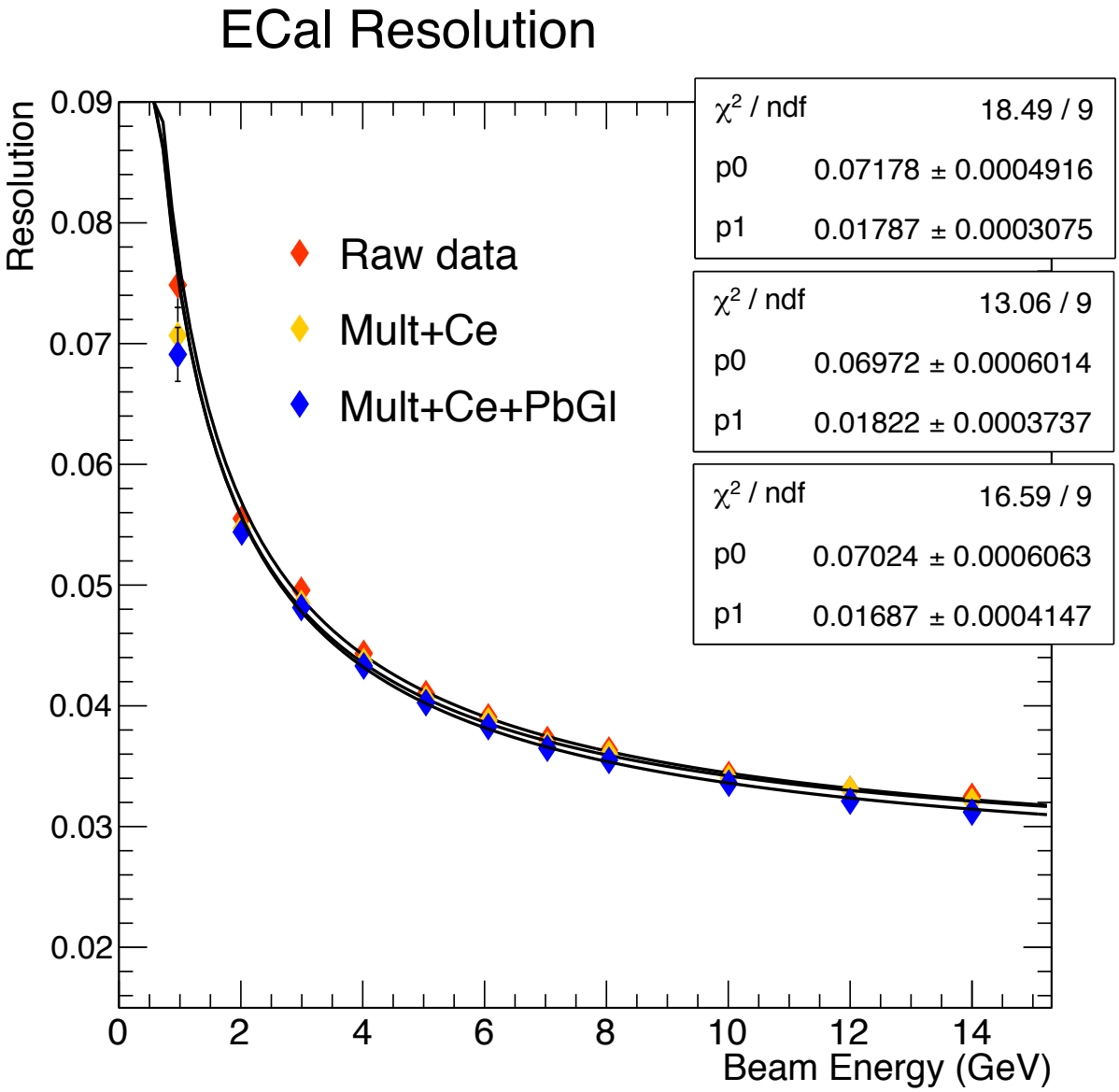
New detector (S) 2016 May.



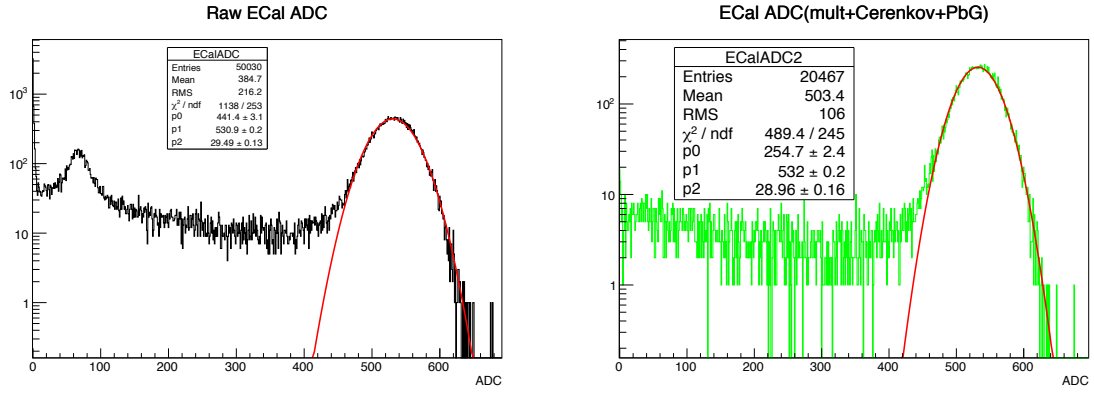
Cuts definition and results:

Raw data: no cuts. Resolution: $\frac{\Delta E}{E} = \frac{7.18\%}{\sqrt{E}} \oplus 1.79\%$;

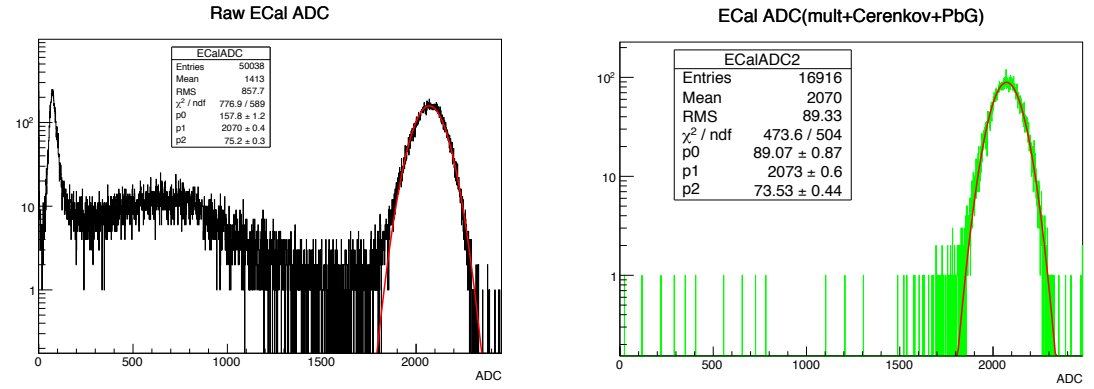
Mult+Ce: multiplicity cut(to select single event) and Cerenkov cut(to select electron events) are applied to raw data. Resolution: $\frac{\Delta E}{E} = \frac{6.97\%}{\sqrt{E}} \oplus 1.82\%$;

Mult+Ce+PbG: multiplicity cut, Cerenkov cut and lead glass calorimeter cut(to eliminate Bremsstrahlung radiation events). Resolution: $\frac{\Delta E}{E} = \frac{7.02\%}{\sqrt{E}} \oplus 1.69\%$.

The fitting function used here is: $f(E) = \sqrt{\frac{p_0^2}{E} + p_1^2 + 0.01875^2}$ (0.01875 is corresponding to beam momentum spread).

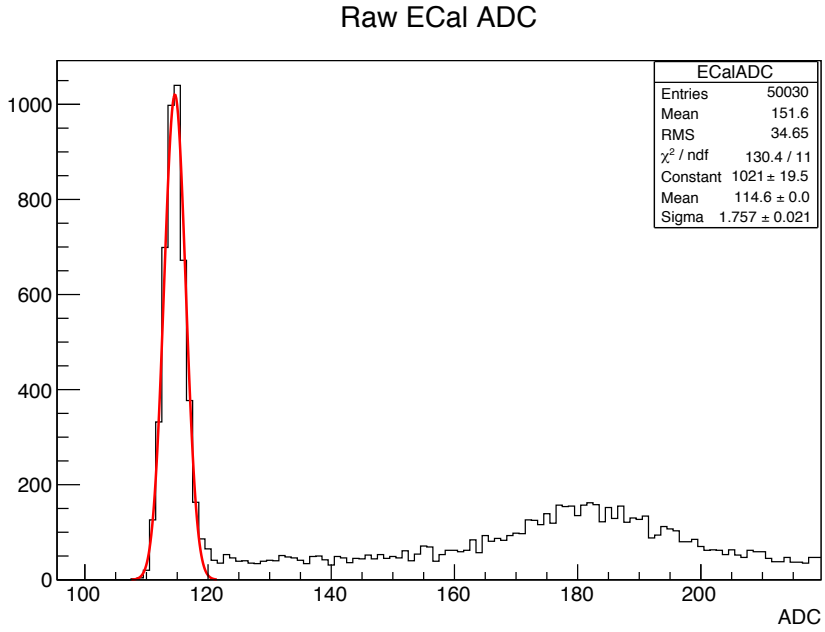


2GeV



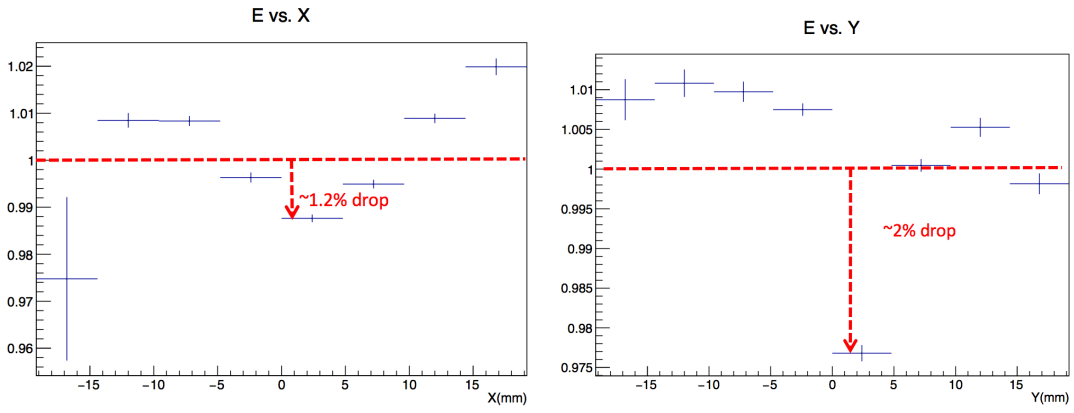
8GeV

Spectra above show the cuts combination effectively cut off hadron/muon events which dominated the left shoulder of electron peaks on raw spectra.

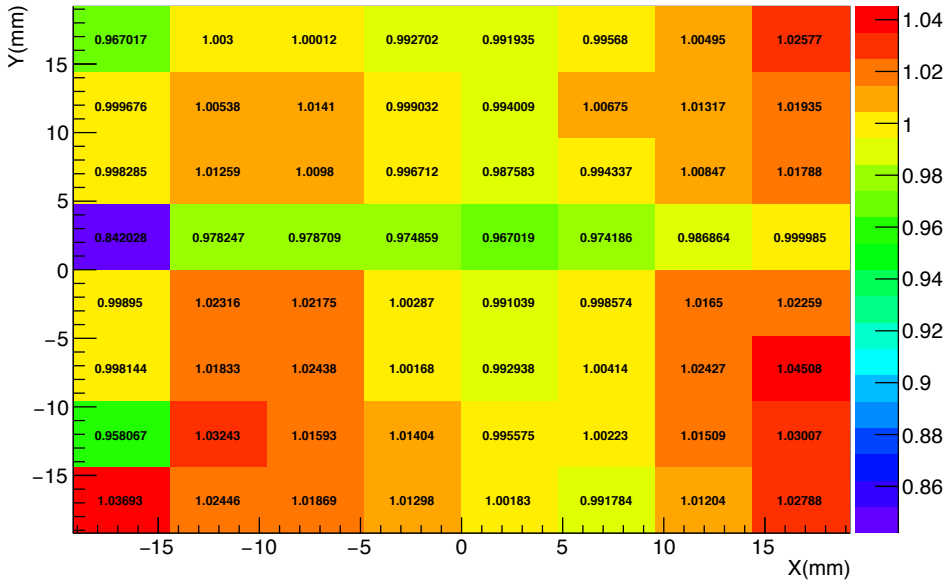


The pedestal spectrum shows electronic noise level is very low and its effect on final resolution measurement can be ignored.

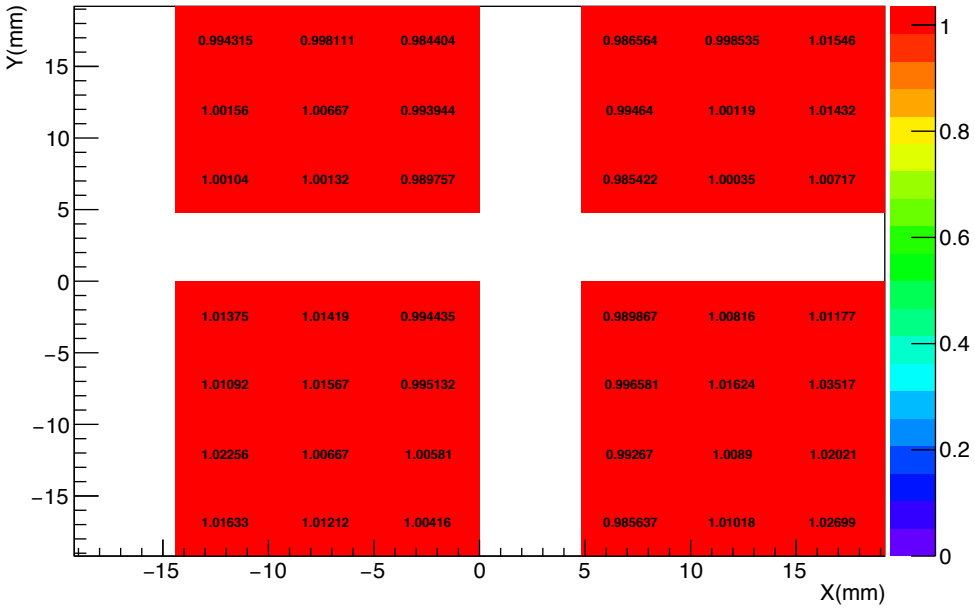
‘Crack’ studies.



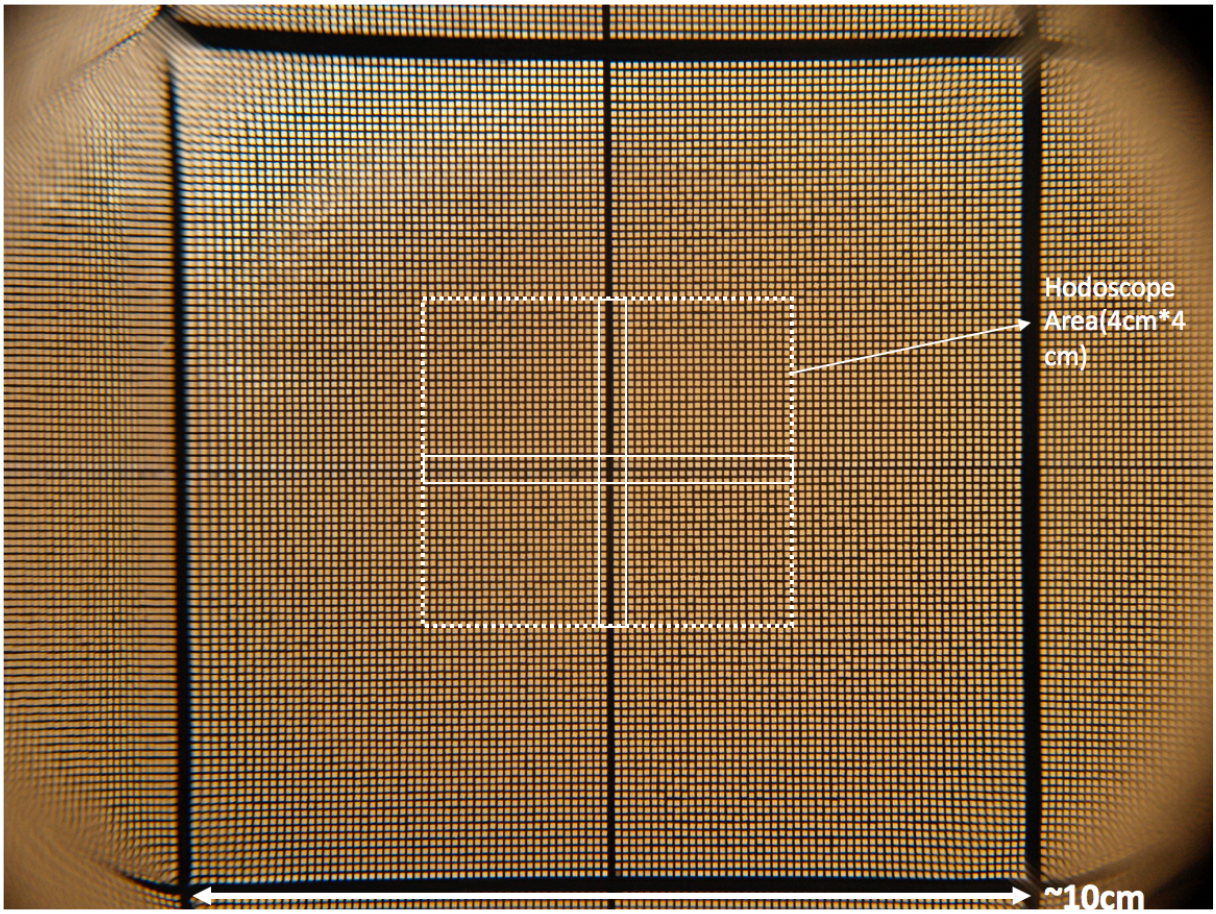
Deposited Energy(normalized) v.s. Hodoscope Position



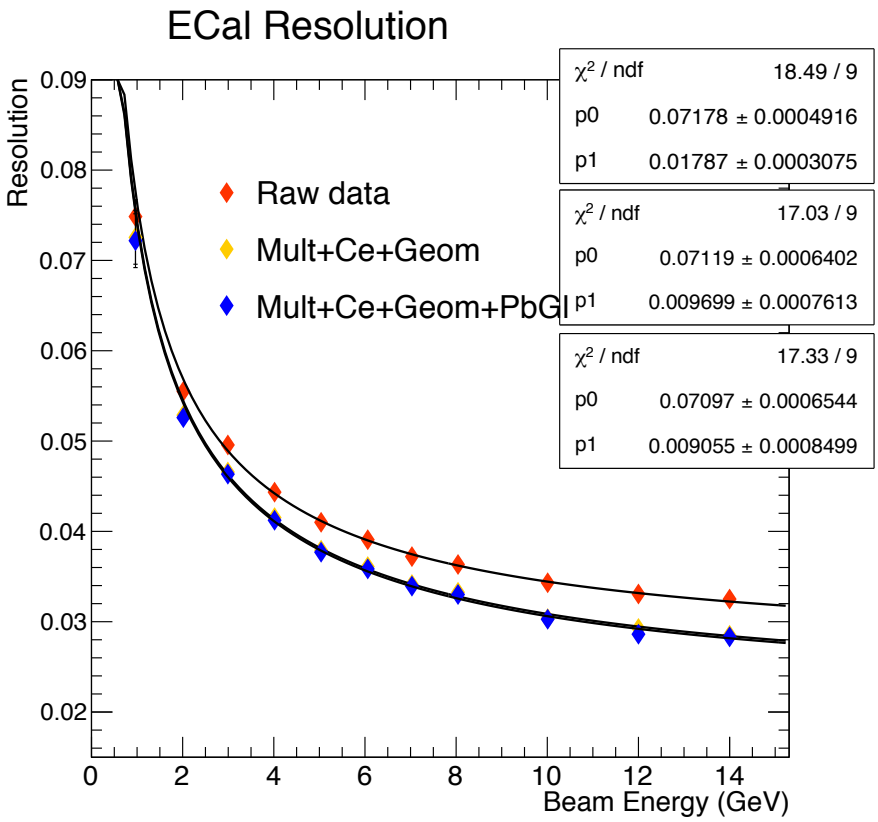
Deposited Energy(normalized) v.s. Hodoscope Position after Geom. Cut



8GeV Data, Geometry cut with hodoscope.



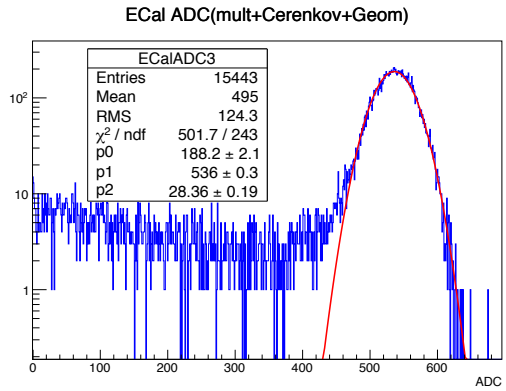
Front Face of S Detector.

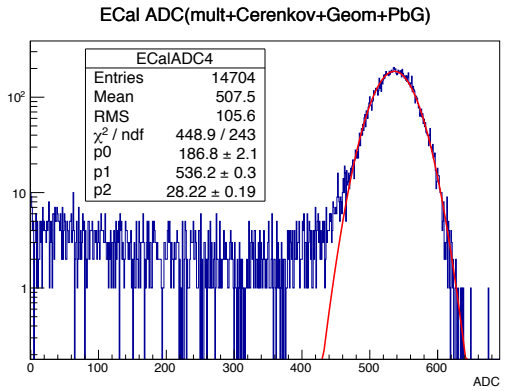


ECal Resolution vs. Energy

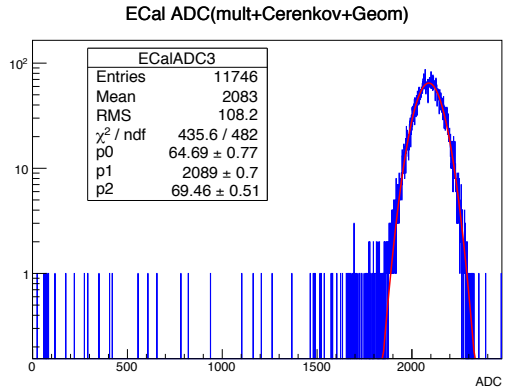
From deposited energy profile, we observed dips in the center of X and Y directions, which are due due to 'cracks' between modules(marked by white rectangle in fiber packing picture). The vertical 'crack' formed when two halves of the calorimeter glued together. The crack in the picture looks wider than it supposed to be be during production. Vertical crack has extra 0.008" of tungsten/epoxy. Horizontal crack has to be pure epoxy.

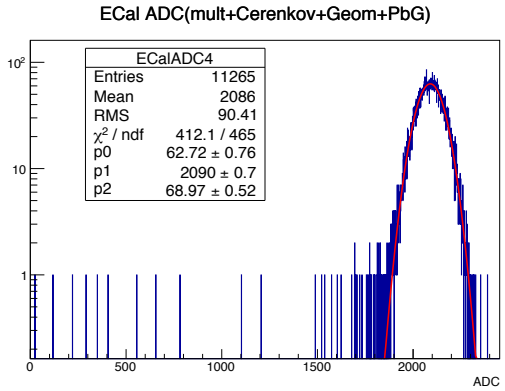
If we apply geometry cut (eliminating hits within +- 2.5 mm within cracks, as shown), energy resolution of ECal is improved for each energy and the constant terms in the fitting are significantly decreased.





2GeV

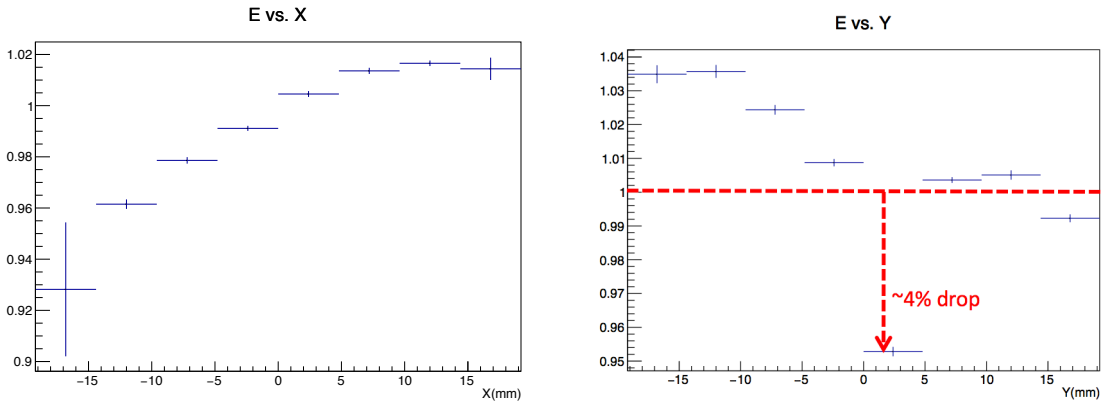


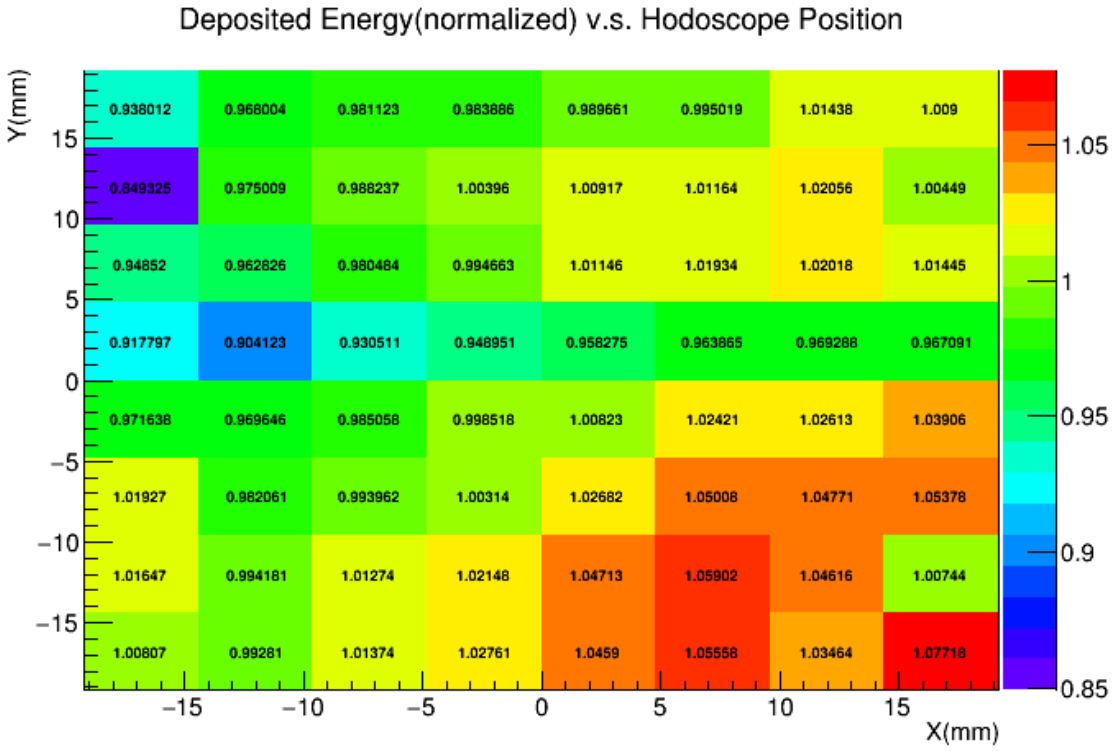


8GeV

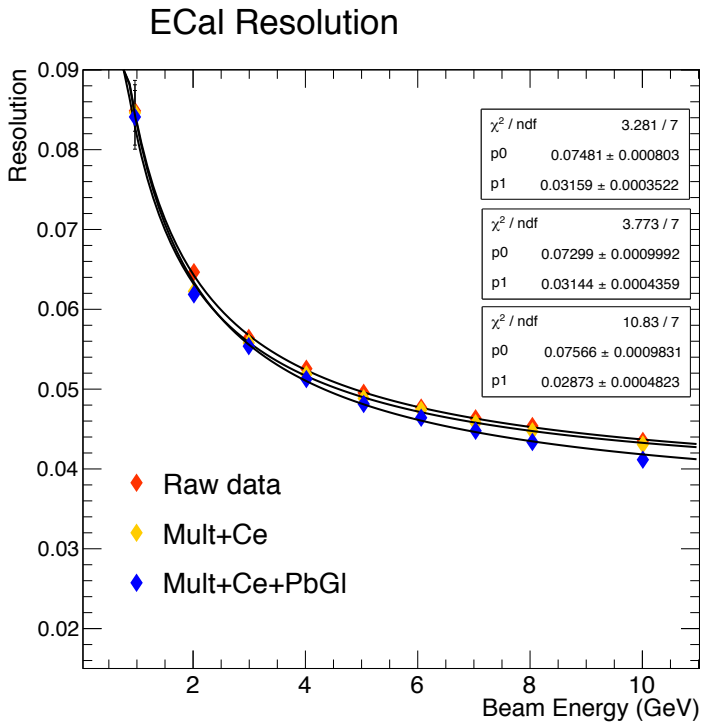
From spectra above, it can be found low energy electron's Bremsstrahlung radiation energy loss cannot be effectively identified by lead glass because of its limited size. A large lead glass wall behind calorimeter can be very helpful.

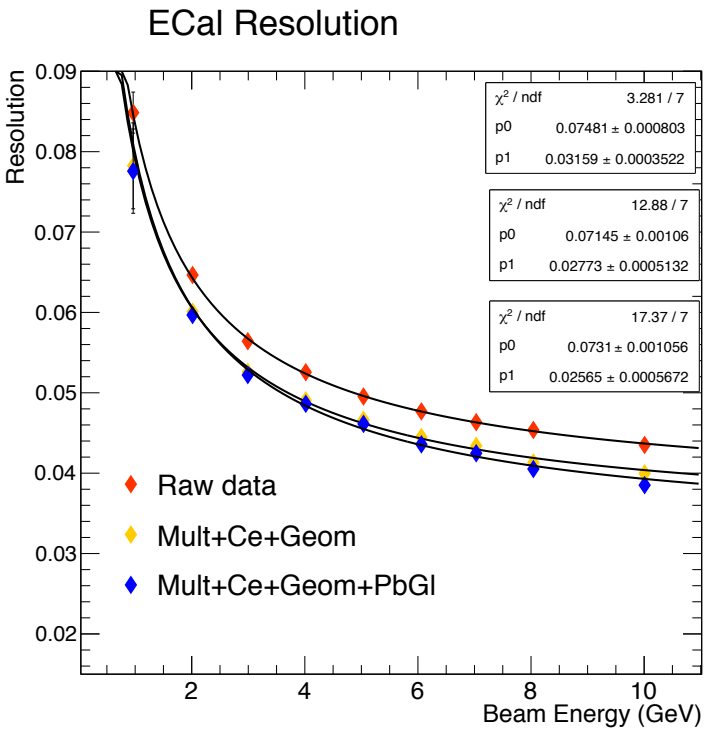
Old Detector





8GeV, Uniformity map.

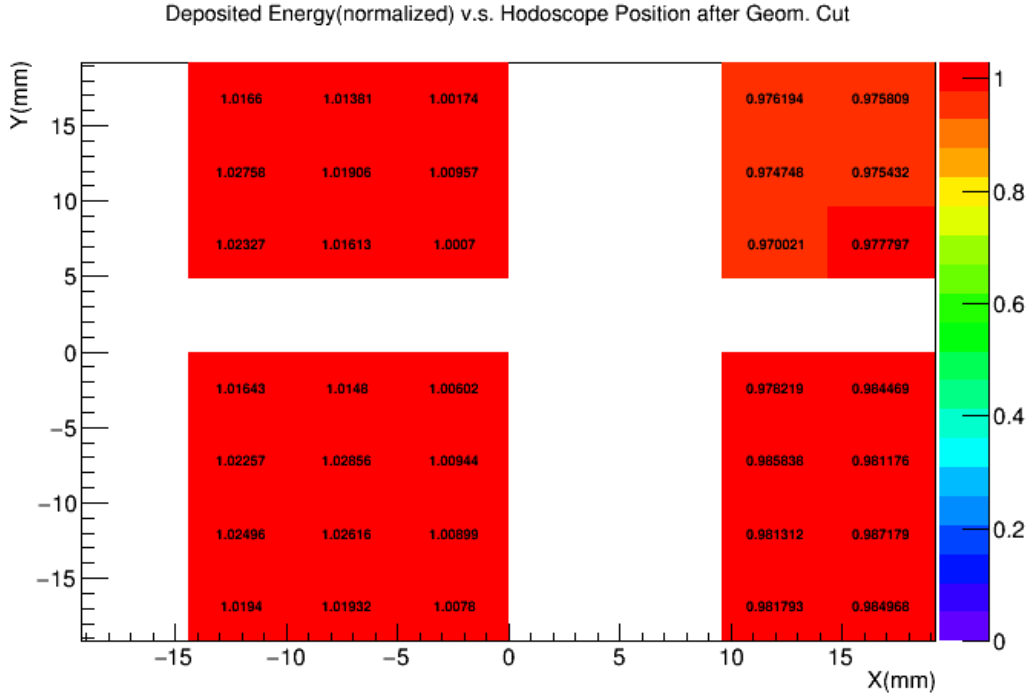




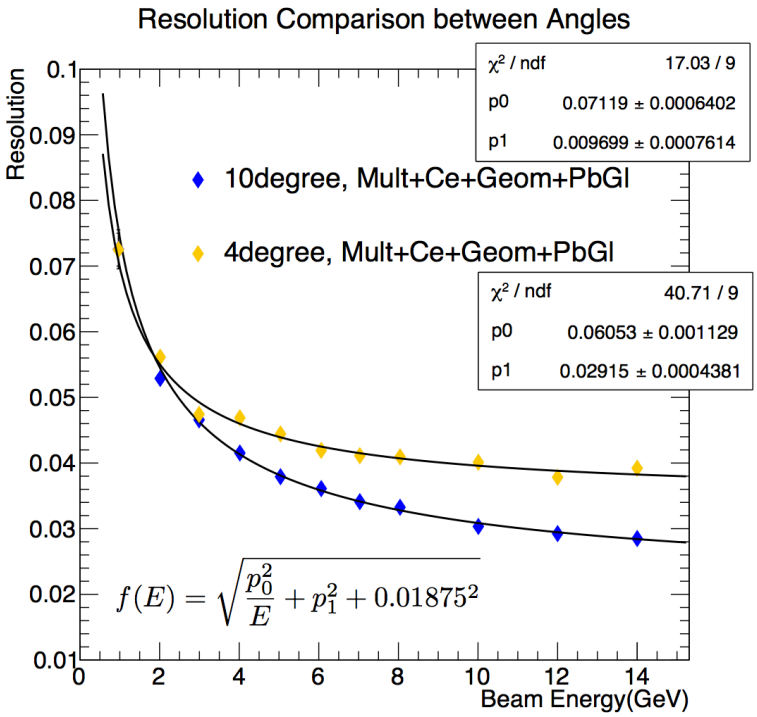
We also observed the energy dip in Y direction in our old detector. By applying the same cuts, we see the constant term is larger than our new design by factor of ~2(fitting

function is the same as shown in last section). This indicates that pure absorber and thicker fiber in our new detector significantly improve our calorimeter's homogeneity, which finally results in substantial improvement of energy resolution of our calorimeter.

S4data and Sdata comparison of new detector: (4 degrees and 10 degrees)



Geom. Cut in 4 degree Run

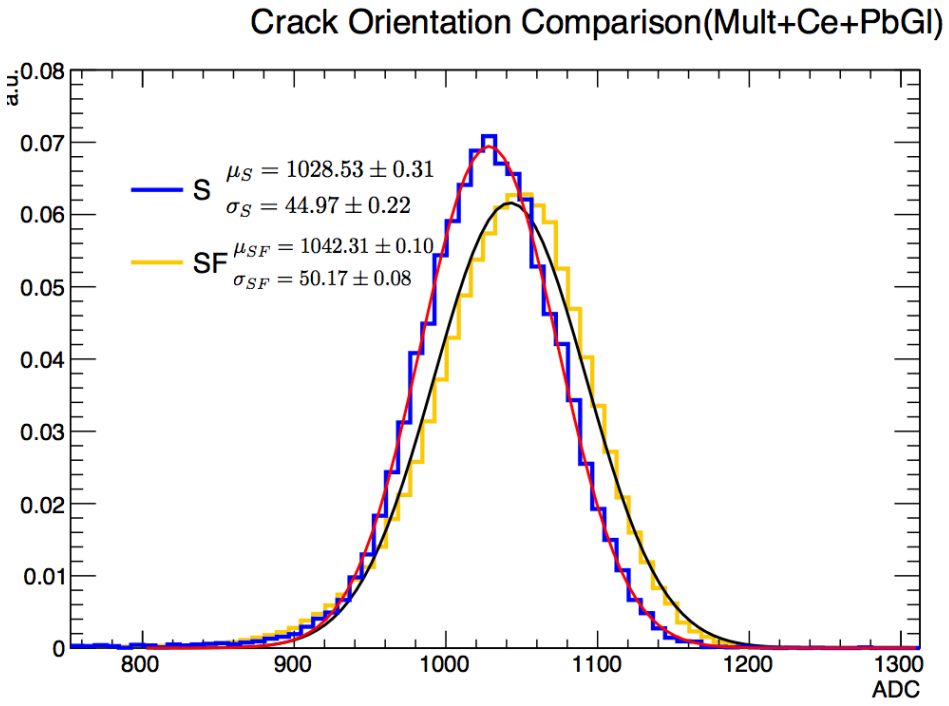


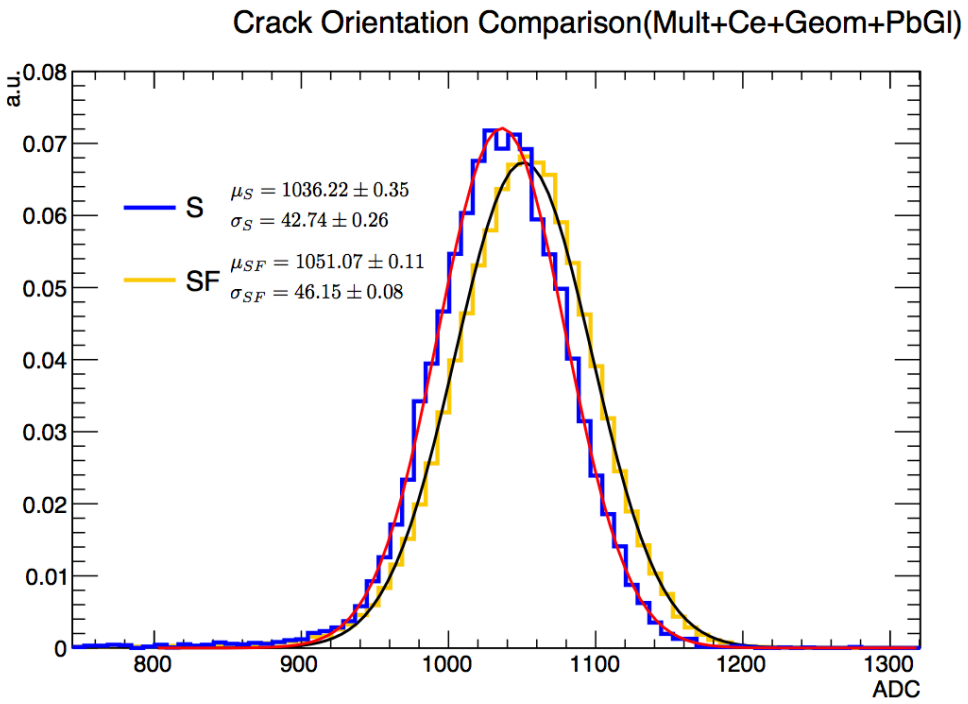
From comparison we can find calorimeter resolution gets worse when beam angle goes down. Also, the fitting indicates the inhomogeneity effect (represented by constant term) becomes pronounced as angle decreases. Simple elimination of the hits near cracks will not help because shower particles still will be loosing energy in the vertical crack. That indicates that for good energy resolution:

a) even small changes in the structure of the detector (inhomogeneity) becomes very important and

b) to reduce effects of such 'cracks' detector should be kept at angles at least 10 degrees.

Comparison between SF and S data





4GeV

Before geometry cut:
SF res.: 4.81%; S res.: 4.37%

SF setup put wider crack in horizontal direction and widens electron peak on ADC spectrum. The peak position is shifted towards higher channel by 1.34%, resolution gets worse by 10.10% compared to S data.

After geometry cut:
SF res.: 4.39%; S res.: 4.12%

After geometry cut, resolution difference between S and SF decreases. But due to the relatively wide range of EM

shower inside detector, energy loss in cracks cannot be completely eliminated. Compared to S data, resolution of SF is worse by 6.46%. The peak position is shifted by 1.43%.